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Kane County, Utah

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

Oct 77

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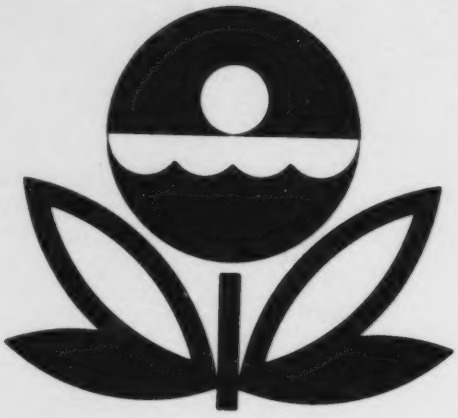
U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



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CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

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REPORT
ON
NAVAJO LAKE
KANE COUNTY
UTAH
EPA REGION VIII
WORKING PAPER No. 848

WITH THE COOPERATION OF THE
UTAH STATE DIVISION OF HEALTH
AND THE
UTAH NATIONAL GUARD
OCTOBER, 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		48G

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CONTENTS

	Page
Foreward	ii
List of Utah Study Lakes and Reservoirs	iv
Lake and Drainage Area Map	v
Sections	
I. Introduction	1
II. Conclusions	1
III. Lake and Drainage Basin Characteristics	3
IV. Water Quality Summary	4
V. Literature Reviewed	7
VI. Appendices	8

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Utah Department of Social Services and the Utah Department of Natural Resources for professional involvement, to the Utah National Guard for conducting the tributary sampling phase of the Survey, and to those Utah wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staffs of the Bureau of Water Quality of the Division of Health and the Division of Wildlife Resources provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

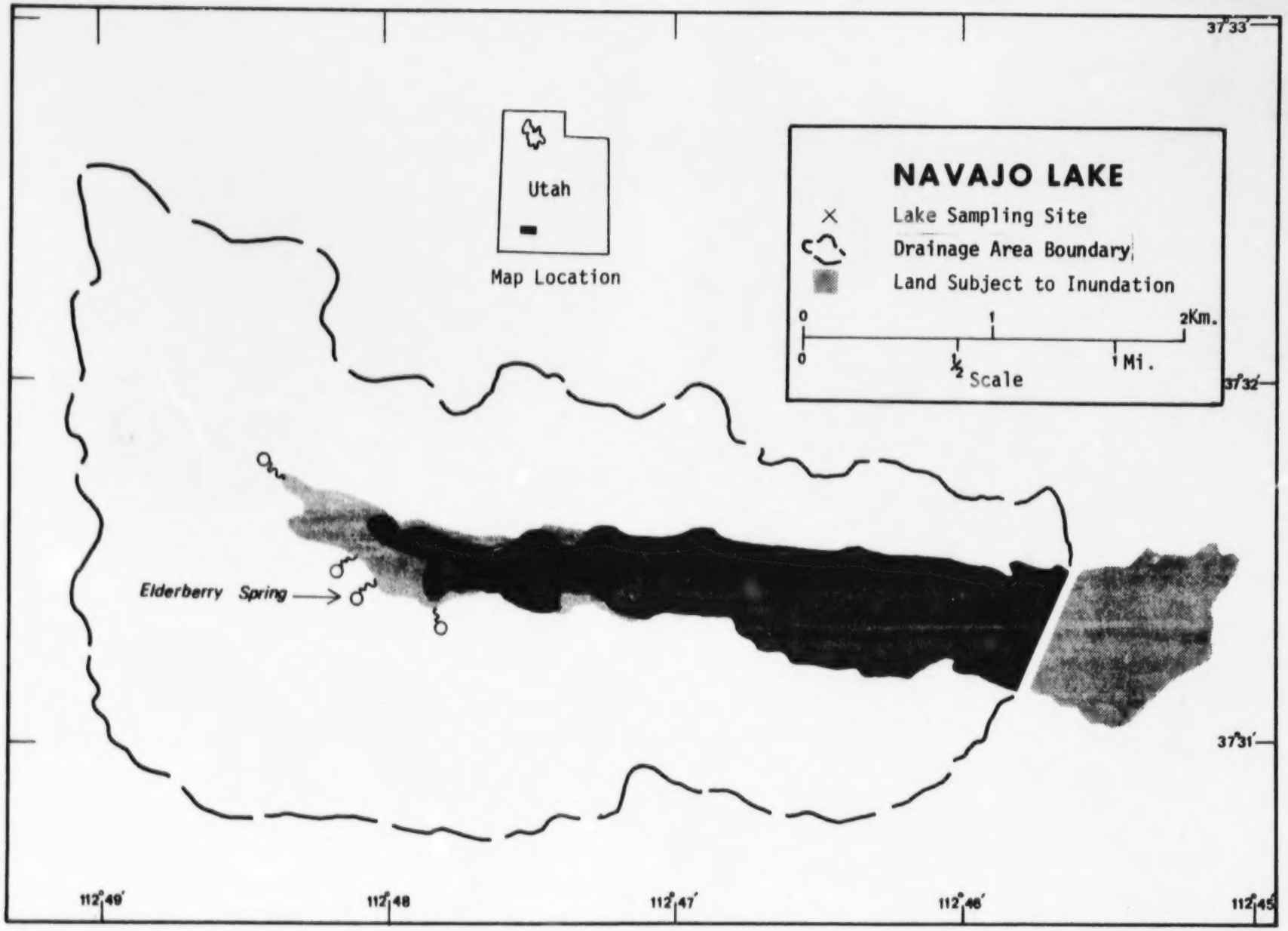
Major General Maurice L. Watts, the Adjutant General of Utah, and Project Officer Lt. Colonel T. Ray Kingston, who directed the volunteer efforts of the Utah National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF UTAH

NAME	COUNTY
Bear	Rich, UT; Bear Lake, ID
Deer Creek	Wasatch
Echo	Summit
Fish	Sevier
Flaming Gorge	Daggett, UT; Sweetwater, WY
Huntington	Emery
Joes Valley	Emery
Lower Bowns	Garfield
Lynn	Box Elder
Minersville	Beaver
Moon	Duchesne
Navajo	Kane
Newcastle	Iron
Otter Creek	Piute
Panguich	Garfield
Pelican	Uintah
Pineview	Weber
Piute	Piute
Porcupine	Cache
Powell	Garfield, Kane, San Juan, UT; Coconino, AZ
Pruess	Millard
Sevier Bridge	Juab, Sanpete
Starvation	Duchesne
Steinaker	Uintah
Tropic	Garfield
Utah	Utah
Willard Bay	Box Elder


37°33'
37°32'
37°31'
112°49'
112°48
112°47'
112°46'
112°45
Utah
Map Location
NAVAJO LAKE
Lake Sampling Site
Drainage Area Boundary
Land Subject to Inundation
0
1
2Km.
0
½
1 Mi.
Scale
Elderberry Spring

NAVAJO LAKE

STORET NO. 4911

I. INTRODUCTION

Navajo Lake has no defined tributaries or outlet. Therefore, this report pertains only to the lake sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate this shallow, spring-fed alpine lake is oligotrophic. However, the occurrence of submerged macrophytes throughout the entire lake reported by Survey limnologists is more indicative of mesotrophy.

Navajo Lake ranked second in overall trophic quality when the 27 Utah lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. Seven of the water bodies had less and one had the same median total phosphorus, one had less and three had the same median orthophosphorus, none of the others had less but ten had the same median inorganic nitrogen, and three had less mean chlorophyll a. The Secchi disc was clearly visible on the bottom of the lake (3.4 - 3.7 m) at both sampling stations and times.

No depression of dissolved oxygen with depth occurred at either sampling station or time; however, the maximum depth sampled was only 2.4 meters.

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of

* See Appendix A.

conditions in the lake because of significant changes in nutrients in the samples from time of collection to the beginning of the assays.

The lake data indicate nitrogen limitation in August and phosphorus limitation in September.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 2.50 kilometers^2.
2. Mean depth: 3.7 meters.
3. Maximum depth: 7.3 meters (?--maximum depth sounded in Survey was 3.7 meters).
4. Volume: 9.250×10^6 m^3.

B. Precipitation*:

1. Year of sampling: 33.8 centimeters.
2. Mean annual: 26.2 centimeters.

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† Table of metric conversions--Appendix B.
†† Sudweeks, 1975.
* See Working Paper No. 175, "...Survey Methods, 1973-1976".

IV. WATER QUALITY SUMMARY

Navajo Lake was sampled two times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two depths at two stations on the lake (see map, page v). During each visit, a single depth-integrated (near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during both visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 2.4 meters at station 1 and 2.1 meters at station 2.

The sampling results are presented in full in Appendix C and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR NAVAJO LAKE
STORET CODE 4911

PARAMETE	1ST SAMPLING (8/13/75) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (9/25/75) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING 0 SITES RANGE	MEAN	MEDIAN
TEMP (C)	17.3 - 17.7	17.5	17.5	15.9 - 16.0	15.9	15.9	******	-**********	
DISS OXY MG/L)	9.0 - 9.2	9.0	9.0	9.4 - 9.8	9.5	9.5	******	-**********	
CNDCTVY (MCROMO)	118. - 121.	119.	119.	78. - 80.	80.	80.	******	-**********	
PH (STAND UNITS)	9.1 - 9.1	9.1	9.1	9.5 - 9.6	9.6	9.6	******	-**********	
TOT ALK (MG/L)	67. - 74.	70.	69.	57. - 67.	61.	59.	******	-**********	
TOT P (MG/L)	0.014 - 0.017	0.015	0.015	0.015 - 0.019	0.017	0.017	******	-**********	
ORTHO P (MG/L)	0.004 - 0.007	0.005	0.005	0.002 - 0.003	0.002	0.002	******	-**********	
NO2+NO3 (MG/L)	0.020 - 0.020	0.020	0.020	0.020 - 0.020	0.020	0.020	******	-**********	
AMMONIA (MG/L)	0.020 - 0.020	0.020	0.020	0.020 - 0.020	0.020	0.020	******	-**********	
KJEL N (MG/L)	0.500 - 0.600	0.550	0.550	0.400 - 0.400	0.400	0.400	******	-**********	
INORG N (MG/L)	0.040 - 0.040	0.040	0.040	0.040 - 0.040	0.040	0.040	******	-**********	
TOTAL N (MG/L)	0.520 - 0.620	0.570	0.570	0.420 - 0.420	0.420	0.420	******	-**********	
CHLRPYL A (UG/L)	2.0 - 2.2	2.1	2.1	1.7 - 2.1	1.9	1.9	******	-**********	
SECCHI (METERS)	****** -**********			3.4 - 3.4	3.4	3.4	******	-**********	

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
08/13/75	1. Flagellates	1,204
	2. *Kirchneriella sp.*	262
	3. *Chroomonas (?) sp.*	105
	4. *Cryptomonas sp.*	79
	5. *Peridinium sp.*	52
	Other genera	104
	Total	1,806
09/25/75	1. *Kirchneriella sp.*	437
	2. *Tetraedron sp.*	312
	3. *Cosmarium sp.*	156
	4. *Oocystis sp.*	156
	5. *Elakatothrix sp.*	62
	Other genera	33
	Total	1,156

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
08/13/75	1	2.0
	2	2.2
09/25/75	1	2.1
	2	1.7

C. Limiting Nutrient Study:

The results of the algal assays are not considered representative of conditions in the lake because of changes in nutrients in the samples from the time of collection to the beginning of the assays.

The lake data indicate nitrogen limitation in August and phosphorus limitation in September. The mean inorganic nitrogen to orthophosphorus ratios were 8 to 1 in August and 20 to 1 in September.

V. LITERATURE REVIEWED

Sudweeks, Calvin K., 1975. Personal communication (lake morphometry). UT Bur. of Env. Health, Salt Lake City.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
0408	LAKE POWELL	0.010	0.410	339.830	3.081	13.800	0.007
4901	BEAR LAKE	0.011	0.040	253.167	0.945	9.200	0.003
4902	LOWER BOWN'S RESERVOIR	0.031	0.040	336.000	5.567	9.400	0.006
4903	DEER CREEK RESERVOIR	0.038	0.215	430.333	9.078	14.800	0.006
4904	ECHO RESERVOIR	0.047	0.170	450.333	6.967	14.000	0.012
4905	LYNN RESERVOIR	0.121	0.200	417.667	39.600	10.400	0.052
4906	FISH LAKE	0.023	0.040	152.000	12.483	10.400	0.004
4907	HUNTINGTON NORTH RESERVO	0.013	0.040	392.000	1.900	7.800	0.005
4908	JOE'S VALLEY RESERVOIR	0.012	0.045	400.000	2.483	11.200	0.003
4909	MINERSVILLE RESERVOIR	0.192	0.060	445.000	33.583	8.600	0.107
4910	MOON LAKE	0.008	0.040	381.000	2.700	9.600	0.002
4911	NAVAJO LAKE	0.016	0.040	368.000	2.000	6.000	0.003
4912	NEWCASTLE RESERVOIR	0.051	0.040	428.667	12.467	13.600	0.009
4913	OTTER CREEK RESERVOIR	0.067	0.040	453.667	11.767	10.600	0.033
4914	PANGUITCH LAKE	0.071	0.040	426.500	45.950	14.200	0.010
4915	PELICAN LAKE	0.044	0.050	438.500	6.350	8.400	0.004
4916	PINEVIEW RESERVOIR	0.028	0.300	435.083	5.692	14.600	0.006
4917	PIUTE RESERVOIR	0.047	0.150	482.625	25.329	11.600	0.007
4918	PORCUPINE RESERVOIR	0.025	0.110	440.000	7.860	12.400	0.011
4919	PRUESS RESERVOIR (GARRIS	0.057	0.140	491.000	4.533	8.800	0.008
4920	SEVIER BRIDGE RESERVOIR	0.026	0.355	449.778	18.222	12.400	0.008
4921	STARVATION RESERVOIR	0.016	0.040	394.583	5.675	13.200	0.004
4922	STEINAKER RESERVOIR	0.011	0.040	316.750	1.844	12.600	0.005
4923	TROPIC RESERVOIR	0.021	0.050	425.000	7.200	8.400	0.006
4924	UTAH LAKE	0.132	0.320	490.583	72.012	11.400	0.012
4925	WILLARD BAY RESERVOIR	0.044	0.060	457.182	7.567	11.000	0.009
5605	FLAMING GORGE RESERVOIR	0.011	0.690	285.636	2.500	10.400	0.003

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	SOO-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
0408	LAKE POWELL	96 (25)	4 (1)	81 (21)	73 (19)	15 (4)	42 (11)	311
4901	BEAR LAKE	90 (23)	87 (19)	96 (25)	100 (26)	77 (20)	90 (23)	540
4902	LOWER BOWN'S RESERVOIR	46 (12)	87 (19)	85 (22)	65 (17)	73 (19)	50 (13)	406
4903	DEER CREEK RESERVOIR	42 (11)	19 (5)	42 (11)	35 (9)	0 (0)	58 (14)	196
4904	ECHO RESERVOIR	31 (8)	27 (7)	19 (5)	50 (13)	12 (3)	13 (3)	152
4905	LYNN RESERVOIR	8 (2)	23 (6)	58 (15)	8 (2)	62 (15)	4 (1)	163
4906	FISH LAKE	62 (16)	65 (16)	100 (26)	23 (6)	62 (15)	79 (20)	391
4907	HUNTINGTON NORTh RESERVO	77 (20)	65 (16)	69 (18)	92 (24)	96 (25)	69 (18)	468
4908	JOE'S VALLEY RESERVOIR	81 (21)	58 (15)	62 (16)	85 (22)	46 (12)	96 (25)	428
4909	MINERSVILLE RESERVOIR	0 (0)	44 (11)	27 (7)	12 (3)	85 (22)	0 (0)	168
4910	MOON LAKE	100 (26)	87 (19)	73 (19)	77 (20)	69 (18)	100 (26)	506
4911	NAVAJO LAKE	69 (18)	87 (19)	77 (20)	88 (23)	100 (26)	85 (22)	506
4912	NEWCASTLE RESERVOIR	23 (6)	87 (19)	46 (12)	27 (7)	19 (5)	27 (7)	229
4913	OTTER CREEK RESERVOIR	15 (4)	87 (19)	15 (4)	31 (8)	54 (14)	8 (2)	210
4914	PANQUITCH LAKE	12 (3)	65 (16)	50 (13)	4 (1)	8 (2)	23 (6)	162
4915	PELICAN LAKE	37 (9)	54 (14)	35 (9)	54 (14)	90 (23)	73 (19)	343
4916	PINEVIEW RESERVOIR	50 (13)	15 (4)	38 (10)	58 (15)	4 (1)	58 (14)	223
4917	PIUTE RESERVOIR	27 (7)	31 (8)	8 (2)	15 (4)	38 (10)	46 (12)	165
4918	PORCUPINE RESERVOIR	58 (15)	38 (10)	31 (8)	38 (10)	33 (8)	19 (5)	217
4919	PRUESS RESERVOIR (GARRIS	19 (5)	35 (9)	0 (0)	69 (18)	81 (21)	37 (9)	241
4920	SEVIER BRIDGE RESERVOIR	54 (14)	8 (2)	23 (6)	19 (5)	33 (8)	37 (9)	174
4921	STARVATION RESERVOIR	73 (19)	87 (19)	65 (17)	62 (16)	23 (6)	79 (20)	389
4922	STEINAKER RESERVOIR	85 (22)	87 (19)	88 (23)	96 (25)	27 (7)	65 (17)	448
4923	TROPIC RESERVOIR	65 (17)	50 (13)	54 (14)	46 (12)	90 (23)	58 (14)	363
4924	UTAH LAKE	4 (1)	12 (3)	4 (1)	0 (0)	42 (11)	13 (3)	75
4925	WILLARD BAY RESERVOIR	37 (9)	44 (11)	12 (3)	42 (11)	50 (13)	31 (8)	216
5605	FLAMING GORGE RESERVOIR	90 (23)	0 (0)	92 (24)	81 (21)	62 (15)	90 (23)	415

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4901	BEAR LAKE	540
2	4911	NAVAJO LAKE	506
3	4910	MOON LAKE	506
4	4907	HUNTINGTON NORTH RESERVO	468
5	4922	STEINAKER RESERVOIR	448
6	4908	JOE'S VALLEY RESERVOIR	428
7	5605	FLAMING GORGE RESERVOIR	415
8	4902	LOWER BOWN'S RESERVOIR	406
9	4906	FISH LAKE	391
10	4921	STARVATION RESERVOIR	389
11	4923	TROPIC RESERVOIR	363
12	4915	PELICAN LAKE	343
13	0408	LAKE POWELL	311
14	4919	PRUESS RESERVOIR (GARRIS	241
15	4912	NEWCASTLE RESERVOIR	229
16	4916	PINEVIEW RESERVOIR	223
17	4918	PORCUPINE RESERVOIR	217
18	4925	WILLARD BAY RESERVOIR	216
19	4913	OTTER CREEK RESERVOIR	210
20	4903	DEER CREEK RESERVOIR	196
21	4920	SEVIER BRIDGE RESERVOIR	174
22	4909	MINERSVILLE RESERVOIR	168
23	4917	PIUTE RESERVOIR	165
24	4905	LYNN RESERVOIR	163
25	4914	PANQUITCH LAKE	162
26	4904	ECHO RESERVOIR	152
27	4924	UTAH LAKE	75

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/08/12

491101
37 31 28.0 112 47 13.0 3
NAVAJO LAKE
49025 UTAH

11EPALES 2111202
0012 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/08/13	10 55 0000		17.3	9.2		118	9.10	67	0.020K	0.600	0.020	0.004
	10 55 0008		17.4	9.0		118	9.15	69	0.020K	0.600	0.020K	0.007
75/09/25	16 55 0000		15.9	9.4	132L	80	9.60	58	0.020K	0.400	0.020K	0.002
	16 55 0007		15.9	9.8		80	9.60	67	0.020K	0.400	0.020K	0.003

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/13	10 55 0000		0.017	2.0	
	10 55 0008		0.015		
75/09/25	16 55 0000		0.018	2.1	
	16 55 0007		0.015		

K VALUE KNOWN TO BE
LESS THAN INDICATED

L ACTUAL VALUE IS KNOWN TO BE
GREATER THAN VALUE GIVEN

STORET RETRIEVAL DATE 75/08/12

491102
37 31 22.0 112 47 52.0 3
NAVAJO LAKE
49025 UTAH

11EPALES 2111202
0011 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/08/13	11 10	0000	17.7	9.0		121	9.15	68	0.020K	0.500	0.020K	0.005
	11 10	0007	17.7	9.0		120	9.10	74	0.020K	0.500	0.020K	0.005
75/09/25	16 30	0000	16.0	9.4	132 L	80	9.55	57	0.020K	0.400	0.020K	0.002K
	16 30	0007	16.0	9.6		78	9.55	60	0.020K	0.400	0.020K	0.002

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/13	11 10	0000	0.016	2.2	
	11 10	0007	0.014		
75/09/25	16 30	0000	0.019	1.7	
	16 30	0007	0.017		

K VALUE KNOWN TO BE LESS THAN INDICATED

L ACTUAL VALUE IS KNOWN TO BE GREATER THAN VALUE GIVEN